FRICTION WELDING FOR AAAV

PROBLEM / OBJECTIVE

The Marine Corps is developing a new Advanced Amphibious Assault Vehicle (AAAV) to be fabricated from high-strength aluminum armor. One of the manufacturing challenges on this vehicle is development of the most productive and cost-effective method of joining appurtenances to the structure. Appurtenances are threaded aluminum bosses that serve as attachment points for armor panels, electronic components, seats, and other equipment.

There are approximately 1000 appurtenances that must be welded to 2519-T87 plates both inside and outside the vehicle. The present method, fillet welding each appurtenance in place using the manual gas metal arc welding (GMAW) process, is costly and time consuming. Locating, tacking, and welding appurtenances currently requires over 500 man-hours per vehicle. Savings in the production schedule and in costs could result from the development of mechanized or automated appurtenance welding procedures. The goal is to cut total welding time in half, while maintaining or improving weld strength.

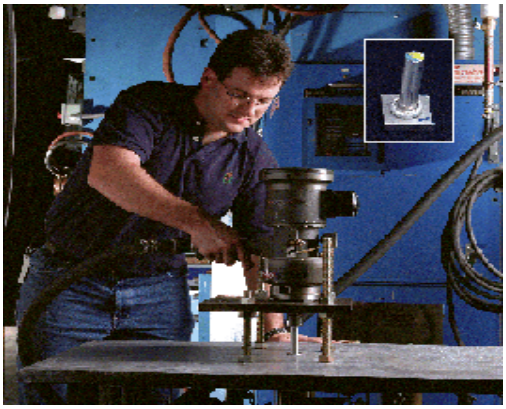
APPROACH / BUSINESS STRATEGY

Initially the NJC evaluated three alternative welding processes for appurtenances: friction welding (FW), resistance projection welding (RPW), and drawn-arc stud welding (SW). This study demonstrated that friction welding has advantages for this application compared to manual GMAW. Optimum welding procedures were developed, mechanical properties evaluated, and process control methods developed to assure production quality is maintained. Final production welding procedures were demonstrated on prototype components and the technology transferred to General Dynamics Land Systems.

ACCOMPLISHMENTS / PAYOFF

Process Improvement

Friction welding of appurtenances has been successfully developed and demonstrated on a production prototype vehicle at GDLS. The procedure uses a direct drive Ram Stud® friction welding machine with a hydraulic motor. This machine was specially modified to allow it to weld appurtenances up to 1.625 inch in diameter. Modifications involved adding a spring loaded collet assembly to hold the appurtenances and flywheels to increase energy output. The design of the appurtenance was adapted to accommodate friction welding. An optimum preweld cleaning method was developed to assure maximum joint strength. Mock up parts were produced and successfully tested. Test data shows that friction welded appurtenances have between 25 and 30% greater strength than the current GMAW method and welds can be produced in about half the time using a mechanized gantry positioning system.



Friction welding of appurtenances was demonstrated on a production prototype vehicle at the GDLS facility in Lima, OH. Six appurtenances were friction welded to the roof of the vehicle. Tests on this vehicle permitted a direct comparison of the performance of friction welded and gas metal arc welded appurtenances.

Other project tasks produced ballistic test panels, developed production process controls, and transitioned the technology to GDLS. Technology transfer included operator training and development of production equipment specifications.

Industry and Navy Acceptance

The NJC worked directly with General Dynamics Land Systems Division and the AAAV Team to ensure that the procedures developed meet design requirements and are compatible with production conditions. Friction welding of appurtenances was demonstrated on a production prototype vehicle at the GDLS facility in Lima, OH. The project included additional tasks to transfer the technology to GDLS. Technology transfer involved operator training and development of production equipment specifications.

Commercialization and Technology Transfer

General Dynamics has procured production equipment and will implement the welding procedures developed on a production basis.

Expected Cost Reduction

The ROI is two-fold for this project. Not only will this process reduce manufacturing costs, but it will also improve performance. Friction welding will streamline the welding process by reducing the time to weld each appurtenance from approximately 30 minutes to approximately 15 minutes. This can result in savings of between 100 and 200 labor hours per vehicle. Other benefits of FW appurtenances are improved precision and integrity of installation and attachment. Weld integrity will be enhanced by reducing residual stress, heat affected zones, and by uniformity of the automated process.

TIMELINE/MILESTONES

Start Date: February 2000
End Date: December 2001

Project activities include the following tasks:

- Development of friction welding procedures for appurtenances using a direct-drive Ram Stud® friction welding machine.
- Evaluation of drawn-arc stud welding (SW) process for appurtenances using a Silicon™ power source and weld head.
- Production of ballistic test panels and development of production process controls.
- Demonstrations on prototype hardware.
- Assistance with production implementation of the developed technologies.

FUNDING

Navy ManTech Expenditures to Date: $213,132

PARTICIPANTS

Development Partners

Edison Welding Institute
Ram Stud® (USA), Inc.
Silicon Equipment
General Dynamics Land Systems Division

Deployment Partners
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